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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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EXAMINER	
THANGAVELU, KANDASAMY	
ART UNIT	**PAPER NUMBER**
2123	

DATE MAILED: 10/06/2004

Please find below and/or attached an Office communication concerning this application or proceeding.

PTO-90C (Rev. 10/03)

Office Action Summary	Application No.	Applicant(s)
	09/896,137	KENNON, STEPHEN R.
	Examiner	Art Unit
	Kandasamy Thangavelu	2123

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *29 June 2001*.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-23* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,2,5-14 and 17-23* is/are rejected.

7)☒ Claim(s) *3,4,15 and 16* is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☒ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

1. Claims 1-23 of the application have been examined.

Drawings

2. The drawings submitted on June 29, 2001 are accepted.

Claim Rejections - 35 USC § 103

3 The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains.

4 The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5 Claims 1, 2, 5, 6, 8-11, 13, 14, 17, 18 and 20-23 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Watts, III** (U.S. Patent 6,052,520) in view of **Sagawa et al.** (U.S. Patent 5,699,271).

5.1 **Watts, III** teaches process for predicting behavior of a subterranean formation. Specifically, as per claim 1, **Watts, III** teaches a method for solving a finite element model corresponding to a system in which there is a multi-phase fluid flow (CL1, L16-26; CL2, L28-37; CL7, L52-55; CL9, L40-42; CL5, L9-15); comprising:

generating a solution for the model using the matrix using finite element techniques (CL3, L23-29; CL7, L60-64).

Watts, III does not expressly teach generating a finite element matrix corresponding to the model, wherein the matrix contains a plurality of coefficients. **Sagawa et al.** teaches generating a finite element matrix corresponding to the model, wherein the matrix contains a plurality of coefficients (CL2, L54-58; CL3, L26-30; CL3, L60-62; CL6, L51-65), because that allows solving the equations through a linear computation (CL3, L29-30). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III** with the method of **Sagawa et al.** that included generating a finite element matrix corresponding to the model, wherein the matrix contained a plurality of coefficients. The artisan would have been motivated because that would allow solving the equations through a linear computation.

Watts, III does not expressly teach adjusting the coefficients to obtain a matrix in which on-diagonal elements are non-negative and off-diagonal elements are non-positive. **Sagawa et al.** teaches adjusting the coefficients to obtain a matrix in which on-diagonal elements are non-negative and off-diagonal elements are non-positive (CL3, L4-5; CL3, L60-62; CL6, L51-65), because that allows solving the equations with reduced computation time (CL2, L48-49). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III** with the method of **Sagawa et al.** that included adjusting the coefficients to obtain a matrix in which on-diagonal elements were non-negative and off-diagonal elements were non-positive. The artisan would have been motivated because that would allow solving the equations with reduced computation time.

5.2 As per claim 2, **Watts, III** and **Sagawa et al.** teach the method of claim 1. **Watts, III** teaches direction of fluid flow across the element (CL6, L33-34). **Watts, III** does not expressly teach adjusting the coefficients comprises weighting the nodes of each element according to a direction of fluid flow across the element. **Sagawa et al.** teaches adjusting the coefficients comprises weighting the nodes of each element across the element (CL3, L16-18; CL5, L37-43), because by automatically selecting the weighting function, a one-to-one correspondence is established between the degree of the weight function and the degree of interpolation of the object variable; so the number of unknowns due to discretization is equal to the number of equations in the system, so the linear equations can be solved through linear computation; and the weight function is assigned considering the attribution of the object variables to the respective partial differential equations, thus resulting in high precision (CL3, L30-43). It would

have been obvious to one of ordinary skill in the art at the time of Applicant's invention to combine the method of **Watts, III** involving direction of fluid flow across the element with the method of **Sagawa et al.** that included adjusting the coefficients comprising weighting the nodes of each element according to the attribution of the object. The artisan would have been motivated because by automatically selecting the weighting function, a one-to-one correspondence would be established between the degree of the weight function and the degree of interpolation of the object variable; so the number of unknowns due to discretization would be equal to the number of equations in the system, so the linear equations could be solved through linear computation; and the weight function would be assigned considering the attribution of the object variables to the respective partial differential equations, thus resulting in high precision.

Per claim 5: **Watts, III** teaches that the finite element matrix corresponds to a system in which there are at least two fluid phases (CL9, L40-42; CL5, L9-15).

Per claim 6: **Watts, III** teaches that the finite element matrix corresponds to a system in which there are three or more fluid phases (CL5, L9-15).

Per claim 8: **Watts, III** teaches that the system corresponds to an oil reservoir (CL1, L16-26; CL3, L23-29).

Per claim 9: **Watts, III** teaches that the matrix is configured to produce a solution which is not physically unrealistic at any time (CL4, L30-39).

Per claim 10: **Watts, III** teaches that the matrix is configured to produce a solution which is non-oscillating (CL4, L30-39).

5.3 As per claim 11, **Watts, III** and **Sagawa et al.** teach the method of claim 1. **Watts, III** teaches discretizing a model of the system to produce a finite element mesh (CL2, L28-37). **Watts, III** does not expressly teach generating the matrix based on the finite element mesh. **Sagawa et al.** teaches generating the matrix based on the finite element mesh (CL2, L54-58; CL3, L26-30; CL3, L60-62; CL6, L51-65), because that allows solving the equations through a linear computation (CL3, L29-30). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III** with the method of **Sagawa et al.** that included generating the matrix based on the finite element mesh. The artisan would have been motivated because that would allow solving the equations through a linear computation.

5.4 As per Claims 13, 14, 17, 18 and 20-23, these are rejected based on the same reasoning as Claims 1, 2, 5, 6 and 8-11, supra. Claims 13, 14, 17, 18 and 20-23 are computer-readable medium claims reciting the same limitations as Claims 1, 2, 5, 6 and 8-11, as taught throughout by **Watts, III** and **Sagawa et al.**

6. Claims 7 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over **Watts, III** (U.S. Patent 6,052,520) in view of **Sagawa et al.** (U.S. Patent 5,699,271), and further in view

of **Benedeck** ("Capacitances of planar multiconductor configuration on a dielectric substrate by a mixed order finite-element method", IEEE 1974).

6.1 As per claim 7, **Watts, III** and **Sagawa et al.** teach the method of claim 1. **Watts, III** does not expressly teach that the finite element matrix corresponds to a four-dimensional finite element model. **Benedeck** teaches that the finite element matrix corresponds to a four-dimensional finite element model (Abstract; Page 281, CL1, Para 6 to CL2, Para 1), because that allows obtaining solutions in the cases of two closely spaced finite elements having large aspect ratios (Page 281, CL1, Para 6). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III** with the method of **Benedeck** that included the finite element matrix corresponding to a four-dimensional finite element model. The artisan would have been motivated because that would allow obtaining solutions in the cases of two closely spaced finite elements having large aspect ratios.

6.2 As per Claim 19, it is rejected based on the same reasoning as Claim 7, <u>supra.</u> Claims 19 is computer-readable medium claim reciting the same limitations as Claim 7, as taught throughout by **Watts, III, Sagawa et al.** and **Benedeck.**

7. Claim 12 is rejected under 35 U.S.C. 103(a) as being unpatentable over **Watts, III** (U.S. Patent 6,052,520) in view of **Sagawa et al.** (U.S. Patent 5,699,271), and further in view of **Fu et al.** ("Time integration procedures for a cyclic thermoviscoplasticity model for Pb-Sn solder applications", IEEE 1996).

7.1 As per claim 12, **Watts, III** teaches discretizing a model of a system in which there is a multiphase fluid flow (CL2, L28-37; CL9, L40-42; CL5, L9-15);

the matrix is configured to produce a solution which preserves linearity (CL7, L60-64); and

generating a solution for the model using the matrix (CL3, L23-29; CL7, L60-64).

Watts, III does not expressly teach a method for obtaining improved accuracy in solving finite element models. **Sagawa et al.** teaches a method for obtaining improved accuracy in solving finite element models (CL3, L39-43), because the method assigns weight functions in consideration of the magnitude of attribution of the object variables to the respective partial differential equations to achieve high precision (CL3, L39-43). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III** with the method of **Sagawa et al.** that included a method for obtaining improved accuracy in solving finite element models. The artisan would have been motivated because the method would assign weight functions in consideration of the magnitude of attribution of the object variables to the respective partial differential equations to achieve high precision.

Watts, III does not expressly teach generating a finite element matrix corresponding to the model. **Sagawa et al.** teaches generating a finite element matrix corresponding to the model (CL2, L54-58; CL3, L26-30; CL3, L60-62; CL6, L51-65), because that allows solving the equations through a linear computation (CL3, L29-30). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III**

with the method of **Sagawa et al.** that included generating a finite element matrix corresponding to the model. The artisan would have been motivated because that would allow solving the equations through a linear computation.

Watts, III does not expressly teach that the matrix is configured to produce a solution which is monotonic. **Fu et al.** teaches that the matrix is configured to produce a solution which is monotonic (Abstract; Figs. 1-4), because that allows comparing the stability of the solution obtained by finite element method with the solution obtained by monotonic testing (Figs. 1-4). It would have been obvious to one of ordinary skill in the art at the time of Applicant's invention to modify the method of **Watts, III** with the method of **Fu et al.** that included the matrix being configured to produce a solution which is monotonic. The artisan would have been motivated because that would allow comparing the stability of the solution obtained by finite element method with the solution obtained by monotonic testing.

Allowable Subject Matter

8. Claims 3, 4, 15 and 16 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 3 includes the method of claim 2 and further includes the limitation "weighting the nodes of each element according to a direction of fluid flow across the element comprises determining the direction of fluid flow across the element and weighting each node more heavily if the node is upstream from the other nodes of the element and less heavily if the node is

downstream from the other nodes of the element". The closest prior art in references by **Watts, III, Sagawa et al., Benedeck** and **Fu et al.** does not teach this limitation. Therefore, this claim is allowable.

Claim 4 includes the method of claim 3 and further includes the limitation "each node is weighted more heavily if a greater portion of the element is downstream from the node than from other nodes of the element and less heavily if a smaller portion of the element is downstream from the node than from other nodes of the element". The closest prior art in references by **Watts, III, Sagawa et al., Benedeck** and **Fu et al.** does not teach this limitation. Therefore, this claim is allowable.

Claim 15 includes the computer-readable medium of claim 14 and further includes the limitation "weighting the nodes of each element according to a direction of fluid flow across the element comprises determining the direction of fluid flow across the element and weighting each node more heavily if the node is upstream from the other nodes of the element and less heavily if the node is downstream from the other nodes of the element". The closest prior art in references by **Watts, III, Sagawa et al., Benedeck** and **Fu et al.** does not teach this limitation. Therefore, this claim is allowable.

Claim 16 includes the computer-readable medium of claim 15 and further includes the limitation "each node is weighted more heavily if a greater portion of the element is downstream from the node than from other nodes of the element and less heavily if a smaller portion of the

element is downstream from the node than from other nodes of the element". The closest prior art in references by **Watts, III, Sagawa et al., Benedeck** and **Fu et al.** does not teach this limitation. Therefore, this claim is allowable.

Conclusion

9. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Dr. Kandasamy Thangavelu whose telephone number is 703-305-0043, till October 27, 2004 and 571-272-3717 after October 27, 2004. The examiner can normally be reached on Monday through Friday from 8:00 AM to 5:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kevin Teska, can be reached on (703) 305-9704, till October 27, 2004 and 571-272-3716 after October 27, 2004. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-305-9600.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for

published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

K. Thangavelu
Art Unit 2123
September 30, 2004

KEVIN J. TESKA
SUPERVISORY
PATENT EXAMINER